Development of Numeric Nutrient Criteria
for NH Rivers and Streams

For Water Quality Standards Advisory Committee

March 24, 2010

Background:

Current Narrative Criteria

Env-Wq 1703.14 Nutrients.

(a) Class A waters shall contain no phosphorus or nitrogen unless naturally occurring.

(b) Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring.

(c) Existing discharges containing either phosphorus or nitrogen which encourage cultural eutrophication shall be treated to remove phosphorus or nitrogen to ensure attainment and maintenance of water quality standards.

(d) There shall be no new or increased discharge of phosphorus into lakes or ponds.

(e) There shall be no new or increased discharge(s) containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.

Notwithstanding a few exceptions, we don't have an objective way to interpret when criteria are violated; Need a numeric translator…. Similar to lakes/ponds, Great Bay

Why do we need to a numeric translator? (i.e. why should we evaluate rivers/stream condition based on nutrients?)
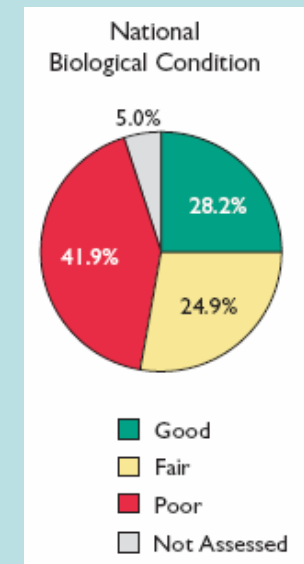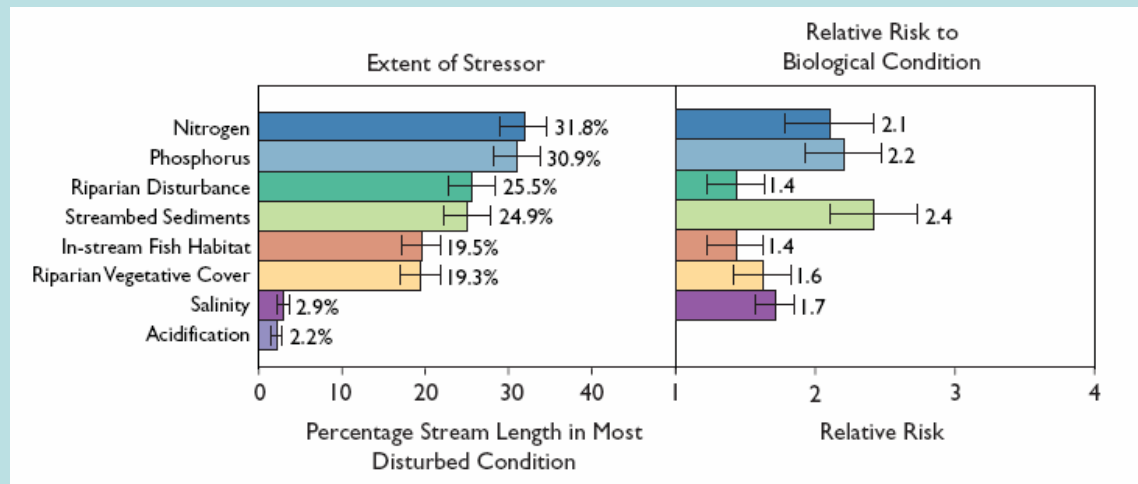
1) Empirical results tell us nutrients are related poor biological conditions

2) Mandate by EPA since 1998 for states to develop numeric criteria; supposed to be in place by 2003; as of 2008 six states have adopted numeric nutrient criteria for all rivers / streams

NH DES approach to numeric nutrient criteria development

1. Review of existing regional criterion

2. Extract and analyze existing data – today's focus

3. Recommend interim numeric criteria

4. Undertake stress / response study

5. Utilize multiple lines of evidence to propose final numeric criteria

Existing / Suggested criteria (Total phosphorus only)

Entity	Criterion (mg/L)	Applicable conditions / Status	Date
EPA	0.100	7Q10 conditions; Outdated	1986
EPA	0.010	Seasonal avg., Current, stratified by ecoregion	2001
NEIWPCC / ENSR	0.012	Seasonal avg., Current, regional	2003
Vermont (DEC)*	0.035	Base flow, Current, proposed, statewide, class B	2009
Maine (DEP)*	0.030	Growing season, Current, proposed, statewide, class B	2009
New York (DEC)*	0.065 / 0.030	Growing season, Current, proposed; statewide	2007

* Uses multiple lines of evidence including stress / response

Data extraction and analysis

Summary of data quantity and analysis steps

- 1990 – 2009: ~40,000 records, >1,100 assessment units (AU), non-random data

- Compute median TP concentration / AU

- Identify percentiles of medians (5, 10, 75, 90, 95)

- Establish AU categories (Reference, No DO impairment, All AUs, DO impaired AUs)

- Compare AU categories using box and cumulative distribution plots

- Overlay ME and VT proposed criteria

EPA recommended techniques for threshold determination

- 75th percentile of reference – Assumes 25% of reference are > threshold (impaired)

- 25th percentile of all data – Assumes 75% of all are > threshold (impaired)

Frequency distributions and the statistical reference condition approach
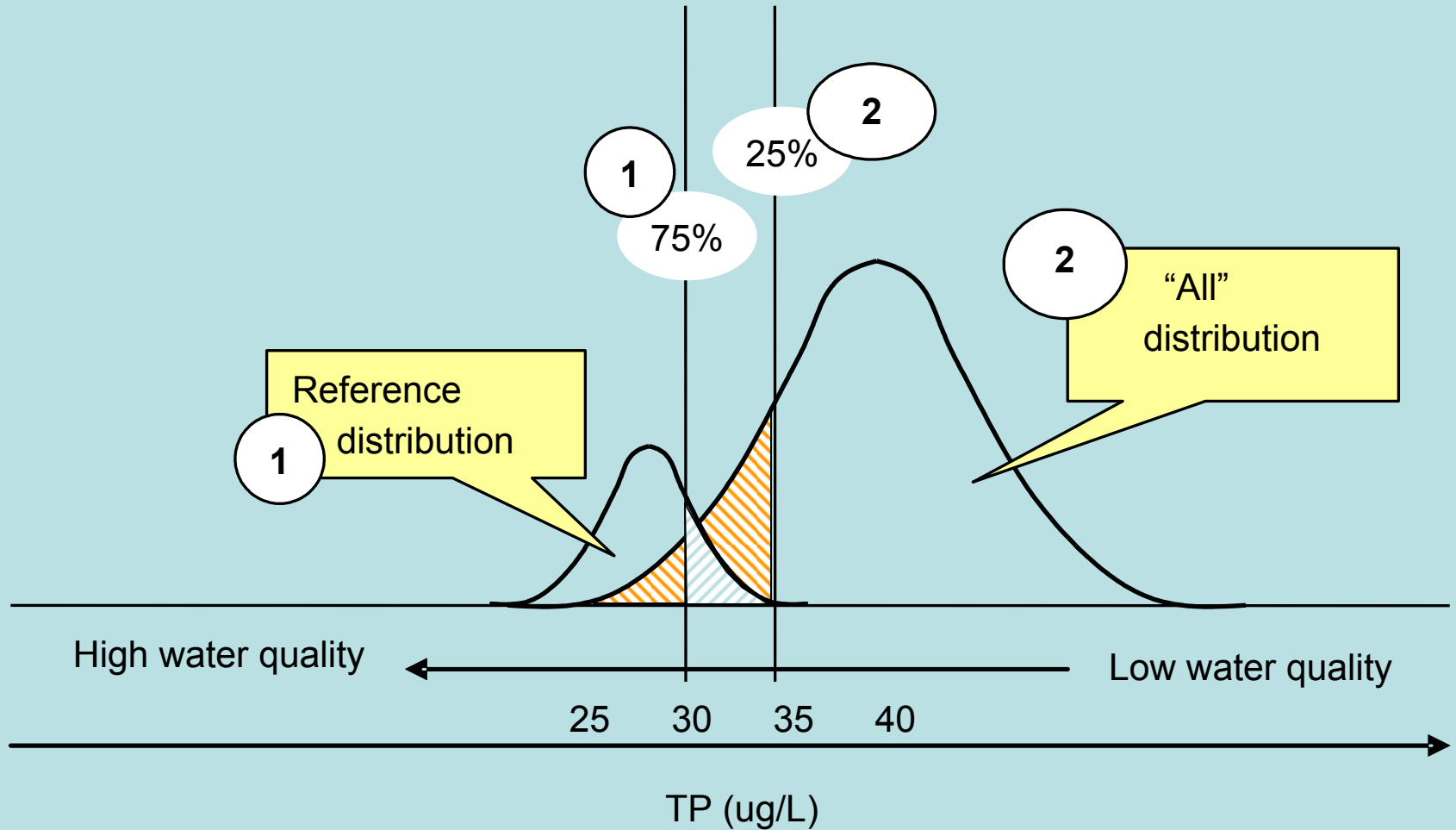
Selection of percentiles is not related to response variables, but provides a basis for describing distribution of data

NH extracted data

Categories:

- **All** – All riverine AUs with $\geq$ 5 TP records, n=677

- **Reference** – All riverine AUs with specific conductance $\leq$ 50 µmhos, $\geq$ 5 TP records, n=186

- **No DO impairment** (alternative reference) – All riverine AUs without documented DO impairment, $\geq$ 5 TP records, n=608

- **DO impairment** – All riverine AUs with documented DO impairment, $\geq$/=5 TP records, n=69

Goal: Establish potential range of TP criterion based on solely on data distribution

Category	Percentile	Rationale
All	10th, 25th	Surrogate to reference
Reference	75th, 90th	low stress; minimal likelihood of impairment
No DO impair	75th, 90th	Alternative definition of reference
DO impair	10th, 25th	Point at which impairment may occur

NH extracted data percentiles / box plots

○ Using EPA recommended approach
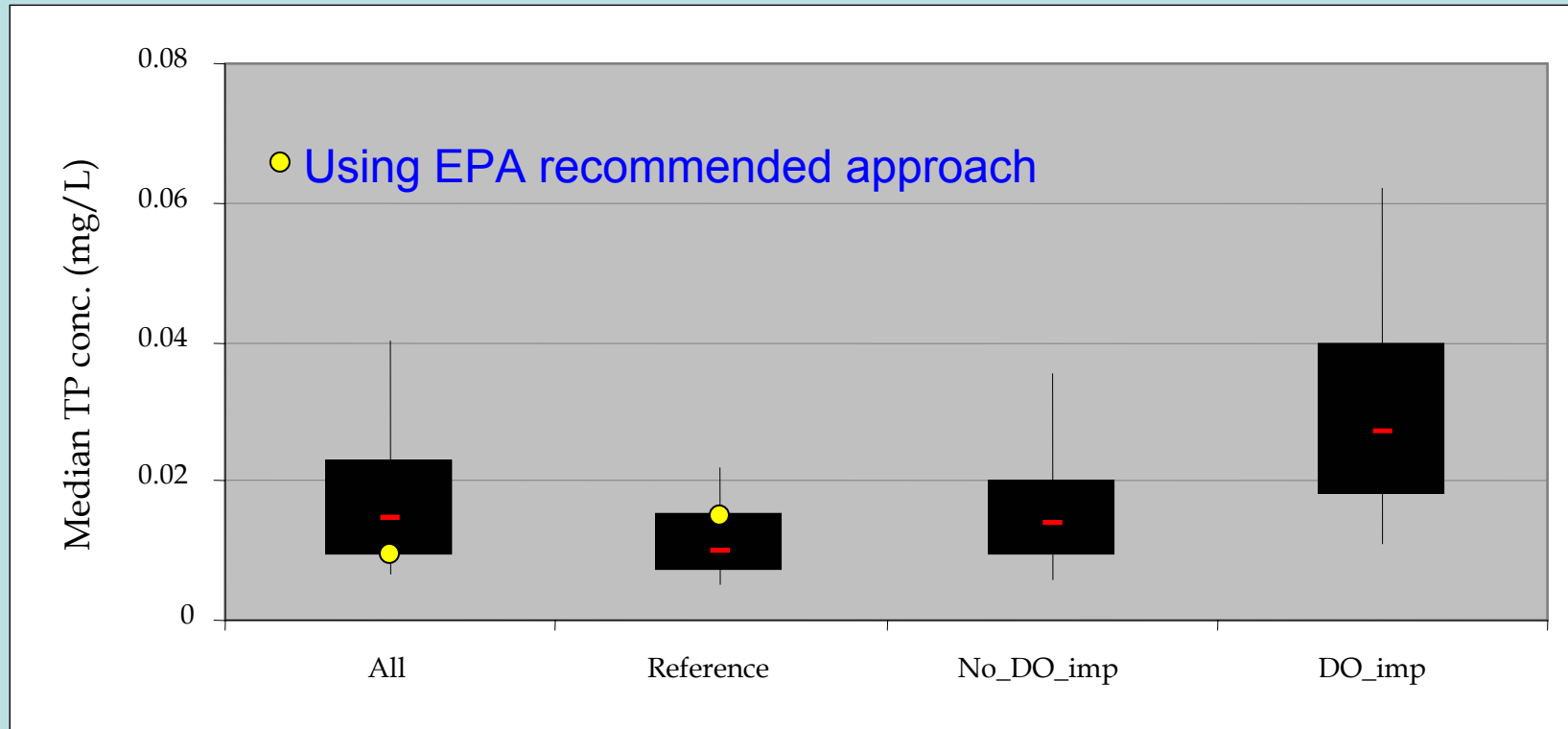
Category	Percentile	Range
All	10th, 25th	0.005 – 0.009
Reference	75th, 90th	0.015 – 0.023
No DO impair (alternative Reference)	75th, 90th	**0.020 – 0.035**
DO impair	10th, 25th	0.011 – 0.018

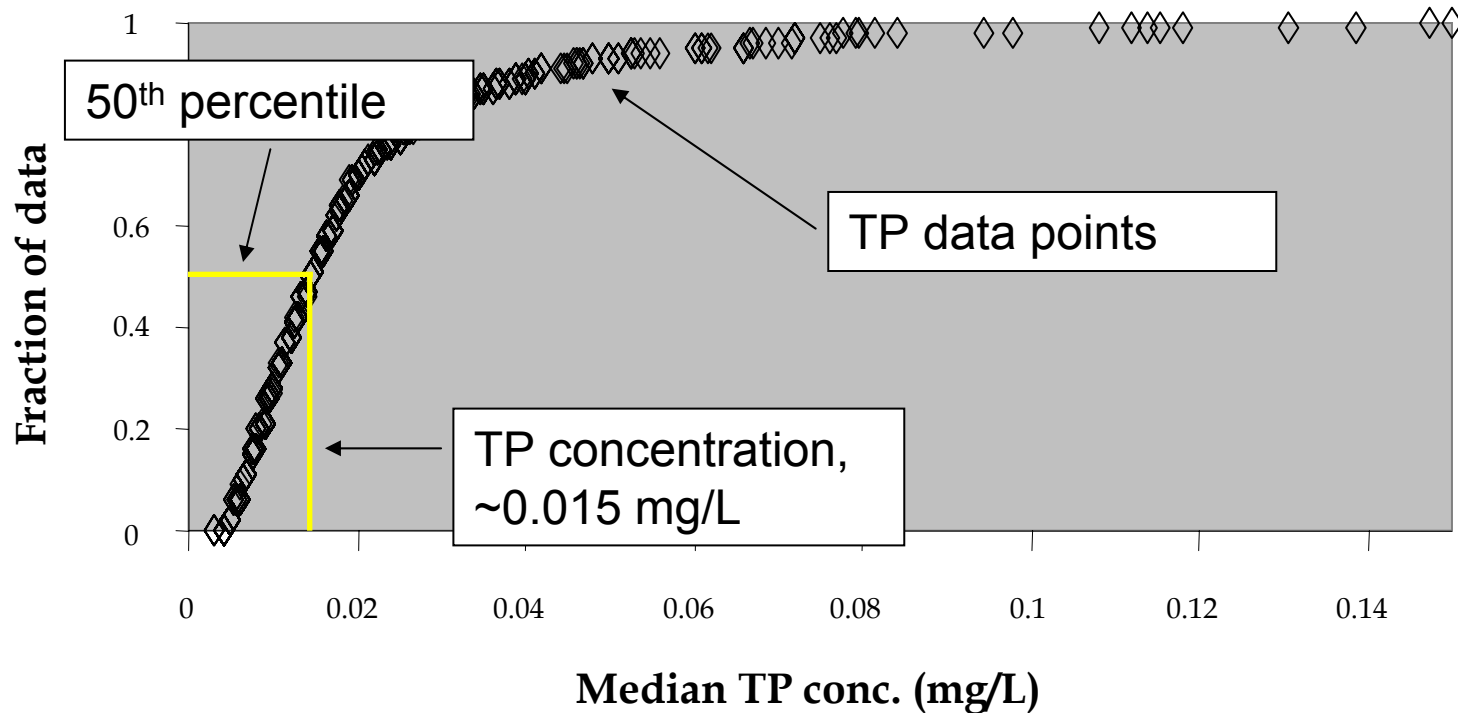Potential Range:

EPA: 0.009 – 0.015

How do NH TP data distributions compare to ME and VT proposed criteria?
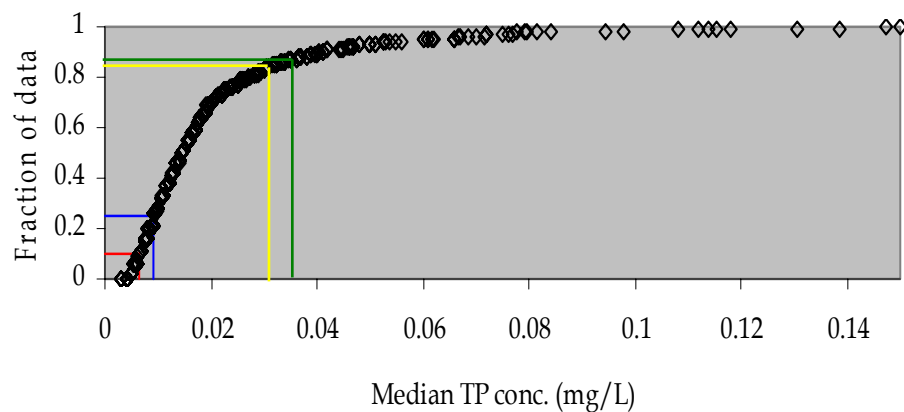
Proposed Criteria: ME class B = 0.030 mg/L

VT class B = 0.035 mg/L

Use cumulative distribution plots:

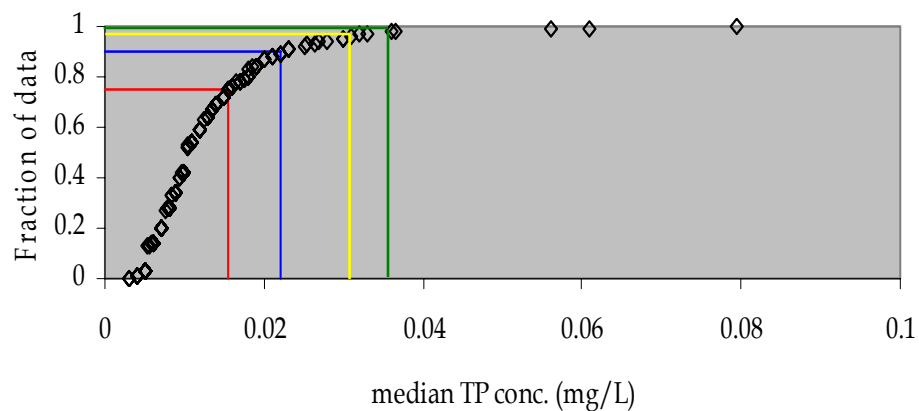**Example:** If 50th percentile was target (50% of data >, 50% of data <), then criteria would be ~0.015 mg/L.

ALL

Fraction of data vs. Median TP conc. (mg/L)

- 10th percentile (red)
- 25th percentile (blue)
- ME (0.030) (yellow)
- VT (0.035) (green)

10th / 25th percentiles << ME / VT criteria

Reference

Fraction of data vs. median TP conc. (mg/L)

- 75th percentile (red)
- 90th percentile (blue)
- ME (0.030) (yellow)
- VT (0.035) (green)
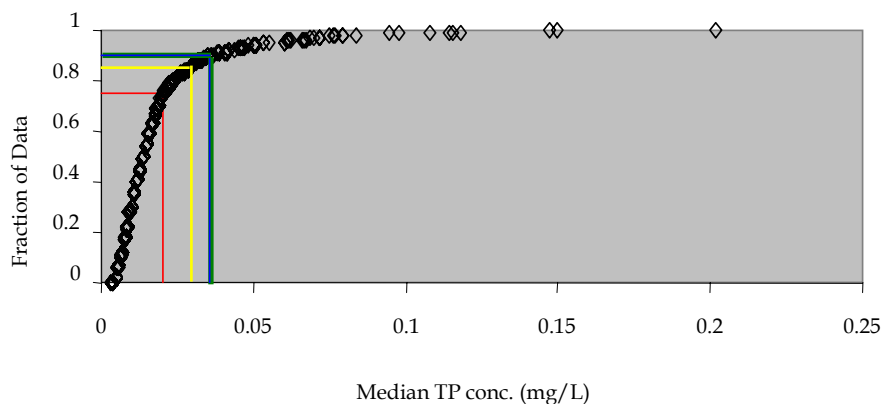
90th percentile < ME / VT criteria

Summary categorical comparisons

Category	Potential threshold range	Comparison to ME & VT	Conclusion
ALL	0.005 – 0.009	<<	Unrealistically low; too strict
Reference	0.015 – 0.023	<	~1/2 of neighboring states; too low
DO impairment	0.011 – 0.018	<<	~1/2 of neighboring states; too low; additional stressors affecting response variable
Reference (alternative)	0.020 – 0.035	Most similar	Consistent with neighboring states; practically acceptable for assessment / enforcement / permitting

EPA recommended threshold identification techniques for neighboring states:

**ME:** All data, 10th percentile = 0.007; 25th percentile = 0.010

VT: All data, 10th percentile = 0.005; 25th percentile = 0.008

Similar to NH TP distribution, but **not** tied to environmental "response"

Environmental response:
Important additional consideration

Current analysis only relies on identifying objective statistical cut points based on distribution of data

Does not take into account response variable (i.e. as nutrients increase then "x" increases / decreases)
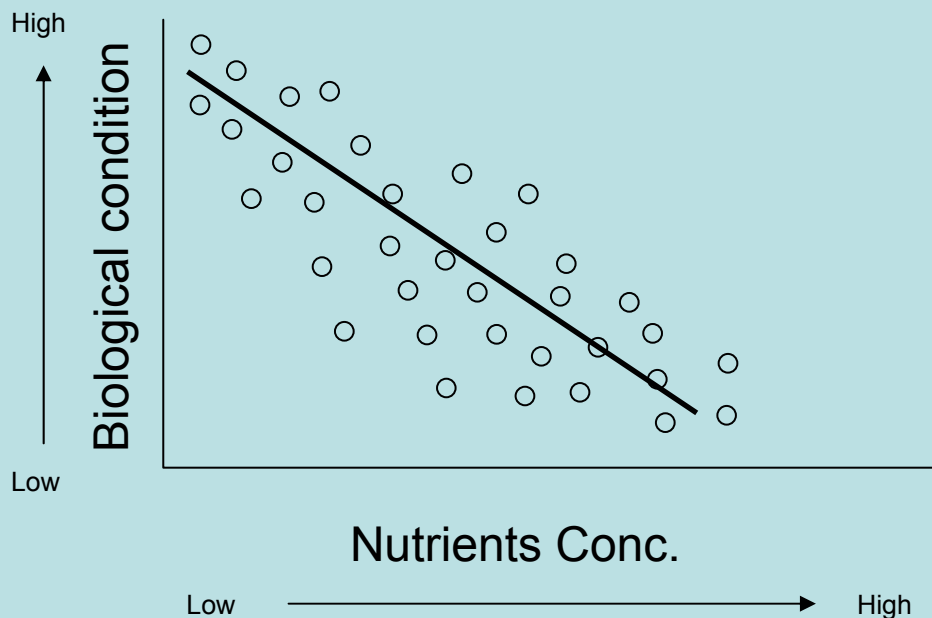

Required element of numeric nutrient criteria development

NY & VT used macroinvertebrates, ME added algae

DES Stress / Response approach

2006 pilot study: periphyton & macroinvertebrates, 9 sites

- Weak (r^2=0.17) relationship between TP and macroinvertebrate index (IBI), nutrient concentration 0.054 mg/L at IBI threshold, > ME / VT

- More data points required to reach final determination of response
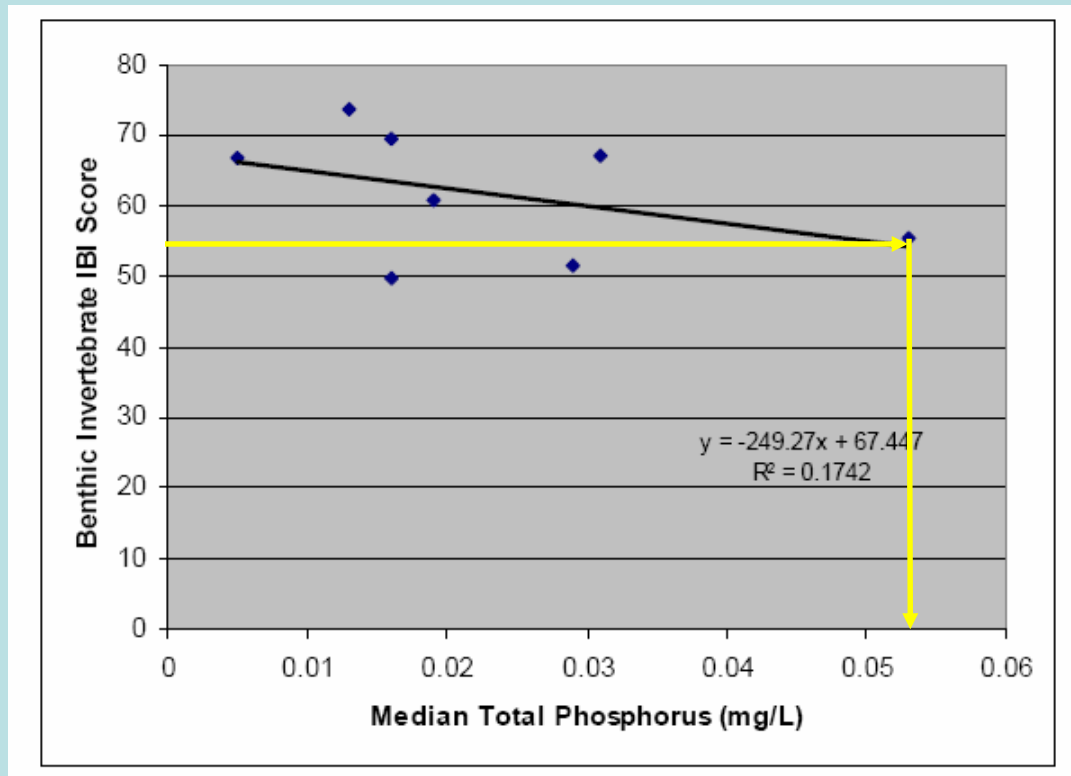
DES Stress / Response approach (con't)

2008 – 09 added additional 30 points to TP / IBI index plot

2009 awarded $65,000 EPA grant to further develop stress / response relationships between nutrients (P and N) and biological indicators (macroinvertebrates / algae)

Project to include 30 additional sites over 2 years (2010-011); plus DES initiated sampling will result in ~100 paired nutrient / macroinvertebrate observations

Algal samples will be collected for composition identification and condition evaluation

Report to be completed by 2012

Will provide recommended numeric nutrient thresholds based on biological community condition

Compare nutrient thresholds based on biological response to thresholds based on nutrient data distribution; satisfies multiple lines of evidence requirement

2013 – Goal for recommendation of proposed final numeric nutrient threshold(s)

Summary

- Regionally derived numeric nutrient thresholds based on EPA recommended frequency distribution approach lower than those derived by individual states; NH - 0.009 – 0.015 mg/L; too low to be enforceable

- **Initial best estimate of low end of range of numeric TP is 0.020 – 0.035 mg/L and based on 75th – 90th percentile of AUs w/out DO impairment**

- **Upper end of TP numeric threshold is assumed to be NY derived biological response estimate (0.065 mg/L) until additional data becomes available**

- **Best estimate of interim criterion = 0.030 mg/L**

- Stress / response relationships between nutrients and macroinvertebrates / algae are under development

- Ultimately, proposed numeric nutrient criteria will be based on multiple lines of evidence that include distribution of nutrient data and stress / response relationships

- Target for establishment of interim numeric nutrient criteria set for year end 2010

- Target for establishment of final proposed numeric nutrient criteria set for year end 2013